Obtained funding: Not applicable
Overall responsibility: NM, EA, AH, AS, AP

REFERENCES

1. Bolia A, Brennan J, Bell PR. Recanalisation of femoro-popliteal occlusions: improving success rate by subintimal recanalisation. Clin Radiol 1989;40:325.
2. London NJ, Srinivasan R, Naylor AR, Hartshorne T, Ratliff DA, Bell PR, et al. Subintimal angioplasty of femoropopliteal artery occlusions: the long-term results. Eur J Vasc Endovasc Surg 1994;8:148-55.
3. Tisi PV, Mirnezami A, Baker S, Tawn J, Parvin SD, Darke SG. Role of subintimal angioplasty in the treatment of chronic lower limb ischemia. Eur J Vasc Endovasc Surg 2002;24:417-22.
4. Lipsitz EC, Ohki T, Veith FJ, Suggs WD, Wain RA, Cynamon J, et al. Does subintimal angioplasty have a role in the treatment of severe lower extremity ischemia? J Vasc Surg 2003;37:386-91.
5. Laxdal E, Jenssen GL, Pedersen G, Aune S. Subintimal angioplasty as a treatment of femoropopliteal occlusions. Eur J Vasc Endovasc Surg 2003;25:578-82.
6. Surowiec SM, Davies MG, Eberly SW, Rhodes JM, Illig KA, Shortell CK, et al. Percutaneous angioplasty and stenting of the superficial femoral artery. J Vasc Surg 2005;41:269-78.
7. El-Barghouty NM, Levine T, Ladva S, Flanagan A, Nicolaides A. Histological verification of computerized carotid plaque characterization. Eur J Vasc Endovasc Surg 1996;11:414-6.
8. Lal BK, Hobson RW 2nd, Pappas PJ, Kubicka R, Hameed M, Chakhtoura EY, et al. Pixel distribution analysis of B-mode ultrasound scan images predicts histologic features of atherosclerotic carotid plaques. J Vasc Surg 2002;35:1210-7.
9. El-Barghouty N, Geroulakos G, Nicolaides A, Androulakis A, Bahal V. Computer-assisted carotid plaque characterisation. Eur J Vasc Endovasc Surg 1995;9:389-93.
10. Lal BK, Hobson RW 2nd, Hameed M, Pappas PJ, Padberg FT Jr, Jamil Z, et al. Noninvasive identification of the unstable carotid plaque. Ann Vasc Surg 2006;20:167-74.
11. Sabetai MM, Tegos TJ, Nicolaides AN, El-Atrozy TS, Dhanjil S, Griffin M, et al. Hemispheric symptoms and carotid plaque echomorphology. J Vasc Surg 2000;31:39-49.
12. Grogan JK, Shaalan WE, Cheng H, Gewertz B, Desai T, Schwarze G, et al. B-mode ultrasonographic characterization of carotid atherosclerotic plaques in symptomatic and asymptomatic patients. J Vasc Surg 2005; 42:435-41.
13. Biasi GM, Sampaolo A, Mingazzini P, De Amicis P, El-Barghouty N, Nicolaides A. Computer analysis of ultrasonic plaque echolucency in identifying high risk carotid bifurcation lesions. Eur J Vasc Endovasc Surg 1999;17:476-9.
14. Kakkos SK, Stevens JM, Nicolaides AN, Kyriacou E, Pattichis CS, Geroulakos G, et al. Texture analysis of ultrasonic images of symptomatic carotid plaques can identify those plaques associated with ipsilateral embolic brain infarction. Eur J Vasc Endovasc Surg 2007;33:422-9.
15. Biasi GM, Froio A, Diethrich EB, Deleo G, Galimberti S, Mingazzini P, et al. Carotid plaque echolucency increases the risk of stroke in carotid stenting: the Imaging in Carotid Angioplasty and Risk of Stroke (ICAROS) study. Circulation 2004;110:756-62.
16. Kakkos SK, Nicolaides A, Kyriacou E, Pattichis CS, Geroulakos G. Effect of zooming on texture features of ultrasonic images. Cardiovasc Ultrasound 2006;4:8.
17. El-Atrozy T, Nicolaides A, Tegos T, Zarka AZ, Griffin M, Sabetai M. The effect of B-mode image standardization on the echogenicity of symptomatic and asymptomatic carotid bifurcation plaques. Int Angiol 1998;17:179-86.
18. Sabetai MM, Tegos TJ, Nicolaides AN, Dhanjil S, Pare GJ, Stevens JM. Reproducibility of computer-quantified carotid plaque echogenicity: can we overcome subjectivity? Stroke 2000;31:2189-96.
19. Geroulakos G, Ramaswami G, Nicolaides A, James K, Labropoulos N, Belcaro G, et al. Characterization of symptomatic and asymptomatic carotid plaques using high-resolution real-time ultrasonography. Br J Surg 1993;80:1274-7.
20. Ramaswami G, Tegos T, Nicolaides AN, Dhanjil S, Griffin M, AlKutoubi A, et al. Ultrasonic plaque character and outcome after lower limb angioplasty J Vasc Surg 1999;29:110-9.
21. Ascher E, Mazzariol F, Hingorani A, Salles-Cunha S, Gade P. The use of duplex ultrasound arterial mapping as an alternative to conventional arteriography for primary and secondary infrapopliteal bypasses. Am J Surg 1999;178:162-5.
22. Ascher E, Hingorani A, Markevich N, Yorkovich W, Schutzer R, Hou A, et al. Role of duplex arteriography as the sole preoperative imaging modality prior to lower extremity revascularization surgery in diabetic and renal patients. Ann Vasc Surg 2004;18:433-9.
23. Ascher E, Hingorani A, Markevich N, Costa T, Kallakuri S, Khanimoy Y. Lower extremity revascularization without preoperative contrast arteriography: experience with duplex ultrasound arterial mapping in 485 cases. Ann Vasc Surg 2002;16:108-14.
24. Ascher E, Marks NA, Schutzer RW, Hingorani AP. Duplex-guided balloon angioplasty and stenting for femoropopliteal arterial occlusive disease: an alternative in patients with renal insufficiency. J Vasc Surg 2005;42:1108-13.
25. Ascher E, Marks NA, Hingorani AP, Schutzer RW, Nahata S. Duplex-guided balloon angioplasty and subintimal dissection of infrapopliteal arteries: early results with a new approach to avoid radiation exposure and contrast material. J Vasc Surg 2005;42:1114-21.
26. Ascher E, Marks NA, Hingorani AP, Schutzer RW, Mutyala M. Duplex-guided endovascular treatment for occlusive and stenotic lesions of the femoral-popliteal arterial segment: a comparative study in the first 253 cases. J Vasc Surg 2006;44:1230-7.
27. Ascher E, Hingorani AP, Marks NA. Popliteal artery volume flow measurement: a new and reliable predictor of early patency after infrainguinal balloon angioplasty and subintimal dissection. J Vasc Surg 2007; 45:17-23.
28. Ostling G, Hedblad B, Berglund G, Gonçalves I. Increased echolucency of carotid plaque in patients with type 2 diabetes. Stroke 2007;38: 2074-8.

Submitted Jun 4, 2007; accepted Sep 13, 2007.

DISCUSSION

Dr Hasan Dosluoglu (Buffalo, NY): I just wanted to ask you if you used any re-entry devices and how easy were your duplex scans with these re-entry devices? I would assume that the disadvantages of the Outback would be eliminated with your approach. And the second thing is, the re-entry actually occurs right distal to the plaque, so the significance of the last centimeter of the occlusion, I would think, is not as important as the initial 1 cm or so of the reconstitution. So did you do any GSM of the plaque characteristics of that area?

Dr Marks: We used seven Outback catheters since 2005 while our series started in 2003. Outback can be successfully oriented with a needle pointing into the popliteal artery lumen using the duplex guidance alone. Of the seven subintimal angioplasties where re-entry was attempted with the Outback, we were successful in five cases. We did not make any conclusions based on this experience due to heterogenicity of the sample.

Regarding the second question, we did not compare the difference between the GSM of the last 2 cm of the occlusion and intima-media thickness adjacent to it. But intuitively, we tried to re-enter the wire at the least calcified portion of the popliteal or femoral artery beyond occlusion.

Dr Roy Greenberg (Cleveland, Ohio): I just had one question for you relating to the location at which you measure your outcome variable, which was the GSM thickness. Does the location

of the GSM measurement vary based upon where the re-entry site is located? Did the GSM dictate where you would re-enter during the study, thereby altering your conclusions given that this, by definition, is unblinded? For example, if you were to measure a GSM in excess of 25 to 30 in the SFA, would you then decide that re-entry should occur more distally than someone with a thinner GSM?

Dr Marks: We calculated the GSM of the entire occlusive plaque from adventitia to adventitia. We did not compare the GSM of the occluded segment with the GSM of intima-media layer of the adjacent patent segment. Although we noticed that calcifications are rarely focal and usually spread over long arterial segments beyond the occluded portion, we attempted to find the softer and less echogenic intima-media segment to reenter.

Common heterogenicity of the plaque (combination of more and less echogenic parts) encouraged us not to abandon attempts of subintimal angioplasty based on GSM, but to be prepared for difficulties and consider longer time for attempts. We feel that subintimal angioplasty procedures in cases of high GM plaque should be attempted with adjunctive re-entry devices such as Frontrunner [Cordis] or Outback readily available.

Niamh Hynes (Galway, Ireland): We use subintimal quite a lot in our institution, with over 500 cases over the last 4 to 5 years. One of our major contraindications for doing a subintimal angioplasty is if the plaque is very echolucent on duplex. We just use duplex alone for pre-op imaging in over 90% of cases. Do you find any correlation between a low GSM and risk of distal embolization or acute rethrombosis?

Dr Marks: This is yet another parameter to look into. But regarding echolucent plaques, when echolucent occlusion is seen on preoperative duplex scan, we already have a policy for all technologists to bring the physician's attention to these cases as it could be a case of acute or subacute arterial occlusion that could be still amenable for section thrombectomy and thrombolysis. So it's up to the physician to decide in case of echolucent plaques and correlate with patient's symptoms whether it could be acute occlusion. Of course, these cases are more prone to distal embolization, but that's one of the other parameters for us to look into and correlate with our findings.